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EDWARD L. SMITH AND JANIS MCCLAIN

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This paper describes three classification criterion tasks and the rationale for their selection. A set of parameters is defined and then used to describe the item format for the test. The test format and content domain are presented and discussed. Sample testing directions and materials are appended.

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A CRITERION TEST FOR CLASSIFICATION TASKS

The Criterion Tasks

Classification tasks are those involving the formation of subsets of objects or other elements based on the similarity of those elements on a particular variable or set of variables. Single variable classification tasks are those involving subsets of elements such that:

1) members of each subset are the same on a particular variable,
2) members of each subset differ on that variable from the members in all other subsets, and
3) all required elements for which values are defined on the variable are assigned to a subset.

Thirteen classification tasks were identified in an analysis of conceptual skills underlying the K-3 science curriculum (Smith, 1971). Three of these were selected as criterion tasks for study of K-1 classification skill.

C1) Identification of the classification variable (d/pC1).

Given a set of objects which have been classified on a variable, identify the variable upon which the objects are classified by giving the variable name or a value describing the objects in each subset.

C2) Classification on a given variable (fC2v/p).

Given a set of objects, classify them on a variable identified by name.

C3) Classification on any appropriate variable (d/pfC3)

Given a set of objects, classify them on any variable on which they can be distinguished, and identify the variable by giving the variable name or a value describing the objects in each subset.

Because children of this age are often unable to produce variable names even though capable of responding to them (Mussell, B., & Smith, E. L., 1970), no tasks were selected which specifically required the child to produce the variable name. In tasks C1 and C3, where the child is required to identify a variable, either the variable name or values which describe the subsets of elements will be accepted.

Task 3 has two parts which can be scored separately or together. The requirement of values and/or a variable name will aid in evaluating the classification since it may occassionally be difficult to infer the variable for classification selected by the child and/or the precision in the values he uses. The classification and variable identification can be scored separately when inferences can be made with confidence, thus distinguishing between children who cannot classify with a variable from those who simply cannot verbalize the basis of their classification.

Although multivariable classification tasks and classification tasks for variables requiring giving the child an explicit observation/ measurement procedure are of considerable importance in the K-3 science

curriculum, such tasks were not selected for study at this time due to their greater difficulty and complexity.

Some studies indicate that many 5-7 year olds can perform or learn to perform the C3 Task with familiar variables (Kofsky, 1966; Reichard, 1944). However, others indicate that a substantial proportion of children, up to the age of eight, continue to have difficulty with this task (Allen, 1968; Raven, 1967). It seems appropriate to find out whether and how most K-1 children can be taught the simpler tasks before proceeding to the more difficult ones.

Item Forms

Literature on classification in early childhood was consulted in the selection of item forms. The bulk of the literature concerns the C3 Criterion Task, where the child is required to classify objects on any appropriate variable. To complete this task successfully, the child must understand that: 1) The variable to be chosen must differentiate the objects into at least two groups; 2) All objects within each group must have the same value on the variable; 3) All objects must be classified.

In general, item forms in the classification literature have tended to give only minimal information concerning the requirements of the task. Sample item forms include "Put all the same things together," put together "whatever is alike," "whatever goes together," (Inhelder, B, & Piget, J., 1964), "all these that belong together" (Reichard

et al. 1944). These instructions supply the child with only one requirement of the task: that the groups be made up of similar objects. Somewhat more information (i.e., that more than one group must be formed) was supplied in an item form used by Annett (1959): "Some of the [cards] belong together. Sort them into groups so that the ones that go together are in the same group."

Several of the above items by virtue of their ambiguity, might tend to elicit subclassificatory groupings such as those based on some theme (e.g., a baby "goes with a blanket") rather than on a common property. Since the primary goal is to find out whether a child is able to classify things, not whether he can decode ambiguous instructions, item forms have been constructed that maximize information about the requirements of the task.

In addition, the instructions for the test will include a sample classification (with objects and variables not used in the criterion test) performed by the tester just prior to the actual administration of test itmes. The tester will point out to the child that all objects in the sample are classified and that, on the classification variable, the objects are the same within groups but differ between groups. In this way, all the essential features of a sorting task will have been conveyed to the child.

The following item forms will be pilot tested and revised for use in the criterion test:

C1 "I have put these ( ) into groups so that all the ones that are alike in some way are in the same group."

"Why do you think I put the ( ) into these groups?" if a correct response is not given, then, "How are these (a subset) alike?", etc.

C2 "Put all of these ( ) into groups by (variable name). Put them into different groups so that all the ones that are the same (variable name) are in the same group."

C3 "How are these (a subset) alike?", etc.

"Put all of these ( ) into different groups, so that all the ones that are alike in some way are in the same group."

"Why did you put the ( ) into these groups?" If a correct response is not given, then, "How are these (a subset) alike?", etc.

"Now put the ( ) into groups in another way, a different way."

Parameters for Constructing Sets of Elements

The construction of items for the above criterion tasks requires a number of decisions about the format of the sets of elements. These decisions can be defined in terms of the following set of parameters.

1) Heterogeneous vs. homogeneous sets

A set of elements differ on some variables and are the same on others.

Heterogeneous sets--The elements differ in many ways. The values of selected variables can be manipulated systematically, but many other variables can be used as a basis for classification.

Homogeneous sets--The elements differ (in any obvious way) only on designated variables.

2) Number of similarity and difference variables

The elements can be different or similar on each of a designated set of variables. The item can be constucted such that the variable with which the child must deal is the only obvious one which can be used to perform the task correctly (focused) or such that several possible alternatives are available (nonfocused).

3) Number of values per variable

This refers to number of values for each variable that are represented by elements in the set. This also represents the number of subsets formed when classifying on that variable.

4) Number of elements in the set

The total number of elements with which the child will deal is another aspect of the criterion tasks. This parameter interacts with parameters 3 and 5.

5) Number of elements per value

For each variable, the number of elements which will represent each value is another parameter. This also represents the size of the subsets formed if the variable is used for classification. These subsets can contain equal numbers of elements (uniform) or unequal numbers of elements (nonuniform). If uniform subsets are selected, the number in each must be designated.

The Selected Format for the Sets of Elements

These parameters can be expected to influence performance on the criterion tasks to some extent. However, to assess their effects would require extensive testing. The purpose of the test described herein is to assess ability on items representative of requirements of the K-1 science curriculum. The values of the parameters listed below describe a rather narrow class of items; additional tests can be constructed, systematically varying these parameters, in order to assess performance on other classes of items and determine the effects of varying these parameters. Within limits, some parameter values were chosen to facilitate the design of a test of workable length and with a sufficient variety of content. Special cases which might cause difficulty (such as subsets with only one member) have been avoided. A final criterion was simplicity: where more than one parameter value met the above specifications, the least complex alternative was selected.

1) All items deal with homogeneous sets of elements. Both heterogeneous and homogeneous sets are involved in the K-1 science curriculum. The homogeneous sets are less complex.

2) All items employ nonfocused sets of elements. Focused sets of elements appear in the science curriculum only in en route items. The sets of elements for all items differ on three variables. Thus, there are two distractor variables for each item.

3) All the items use sets of elements which represent three values for each variable.

4) All the items involve a set of twelve elements. This number is representative and convenient.

5) All the items employ a set of elements which is nonuniform on each difference variable. Sets of elements which are uniform on important variables are rare. The variables will each have three, four, and five elements for their three values.

Following the above specifications, the composition of variables and values can be summarized:

$p_1 = v_{11}, v_{12}, v_{13}$

$p_2 = v_{21}, v_{22}, v_{23}$

$p_3 = v_{31}, v_{32}, v_{33}$

where p_x = name of variable x, and

v_{xk} = value k for variable x

Following the specifications referred to above, the following combinations of values for twelve objects ($e_1, e_2, \ldots e_{12}$) have been generated for use in the criterion test:

e_1	e_2	e_3	e_4	e_5	e_6	e_7	e_8	e_9	e_{10}	e_{11}	e_{12}
v_{11}	v_{11}	v_{11}	v_{12}	v_{12}	v_{12}	v_{12}	v_{12}	v_{13}	v_{13}	v_{13}	v_{13}
v_{21}	v_{22}	v_{23}	v_{21}	v_{21}	v_{22}	v_{22}	v_{23}	v_{21}	v_{22}	v_{23}	v_{21}
v_{31}	v_{32}	v_{33}	v_{31}	v_{32}	v_{33}	v_{31}	v_{32}	v_{33}	v_{32}	v_{31}	v_{32}

Thus, for example, the fifth object specified (e_5) is described by value 2 on variable 1, value 1 on variable 2, and value 2 on variable 3. A sample set of elements is included in Appendix A.

Criteria for Evaluating Responses

An item is considered passed if the following criteria are met:

Task C1--The child will

a) give a name or phrase identifying the variable (e.g., color, smoothness, how big they are), or

b) give values[1] describing the objects in two or more subsets of elements (e.g., red and blue; rough and smooth; bumpy and not bumpy).

Task C2--The child will

a) form a subset for each of the values of the classifying variable represented in the set[2],

b) correctly classify at least eleven of the twelve objects,

c) not form subsets for values of other variables, and

d) state the appropriate value describing the objects in at least two of the subsets.

Task C3--The child will

a) classify the objects on a variable having at least two different values,

---

[1]Any word or phrase characterizing the subset on the classification variable.

[2]Clearly distinct values will be selected. The items are not designed to test the child's ability to make fine distinctions.

b) form a subset for each of the values of the classifying variable represented in the set,

c) correctly classify at least eleven of the twelve objects,

d) state an appropriate value describing the objects in at least two of the subsets, and

e) not form subsets for values of more than one variable.

Test Format

As stated above, the test covers three classification tasks:

1) identification of the classification variable given a sorted set of objects;

2) classification of a set of objects on a given variable;

3) classification of a set of objects on any appropriate variable.

The test is designed to assess each task with two different variables in the context of each of three different sets of objects. The third variable (p_3) is used only as a distractor variable in C1 and C2 tasks. The child may select any one of the variables for the C3 task. Each child is presented with five items as indicated in Table 1. Three forms of the test will be employed to balance out any special effects of the variables or objects on the data for each task. Children will be randomly assigned to one of the three forms. A listing of all the items for each form of the test is presented in Appendix B.

TABLE 1

FORMAT OF CLASSIFICATION CRITERION TEST

Task	Item	Variable	Set of Objects		
			Form A	Form B	Form C
C1--Identification of the classification variable	1	P_1	E_1	E_2	E_3
	2	P_2	E_2	E_3	E_1
C2--Classification on a given variable	3	P_1	E_2	E_3	E_1
	4	P_2	E_1	E_2	E_3
C3--Classification on any appropriate variable	5	$P_1/P_2/P_3$	E_3	E_1	E_2

Content Domain

The content domain is defined in terms of the class membership of the elements (insects, plants, etc.) and the variables on which the elements differ (both tested variables and distractor variables).

Variables

Two basic types of readily observable variables can be distinguished: quantitative (which can provide a nonarbitrary basis for ordering of elements) and qualitative (which do not provide a basis for ordering). Both types are found in the K-3 science curriculum, although quantitative variables seem to predominate. One qualitative variable, color, and one quantitative variable, number, were selected to be tested. Both of these variables are used in classification tasks in the SCIS unit *Material Objects* (McClain and Smith, 1971). Values for both are taught in the SWRL Instructional Concepts Program (ICP) and data indicate

that most kindergarten children have either already mastered these values or can readily master them (Scott and Martin, 1970; Mussell and Smith, 1970). Many studies of classification have employed color, but none have been found which employed number. Thus, the use of these two variables serves both as replication and extension of the existing literature.

A second qualitative variable, position, was selected to be used as the distractor variable. The main reason for its selection was convenience in construction of the sets of elements, although values for this variable are also taught in the SWRL ICP.

Elements

Several types of elements are involved in classification tasks in the *Material Objects* unit (McClain and Smith, 1971): samples of various materials, (wood, metal, etc.) simple discrete objects, complex objects (those with more than one part or made of more than one kind of material), and systems of objects. Complex objects were selected for the criterion test since this category was used most frequently in the *Material Objects* unit and since complex objects were easily constructed so as to differ systematically on the selected variables. Three kinds of complex objects were selected: plants, insects, and houses. All of the objects are presented pictorially. The sets differ as follows:

houses--number of windows, color of house, and position of windows

plants--number of flowers, color of flowers, and position of flowers

insects--number of spots, color of spots, and position of spots.

Sample pictures are presented in the Appendix A.

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APPENDIX A

SAMPLE SET OF OBJECTS

1

Number of Flowers: 1
Color of Flowers: red
Position of Flowers:
top of plant

2

Number of Flowers: 1
Color of Flowers: yellow
Position of Flowers:
middle of plant

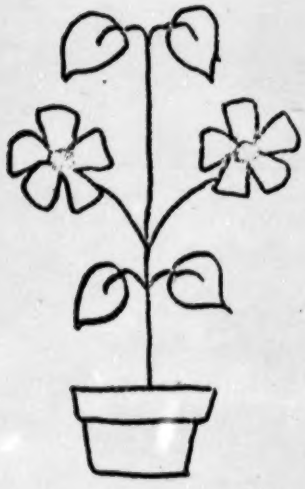
3

Number of Flowers: 1
Color of Flowers: blue
Position of Flowers:
bottom of plant

4

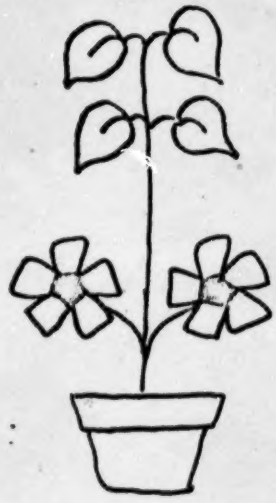
Number of Flowers: 2
Color of Flowers: red
Position of Flowers:
top of plant

5



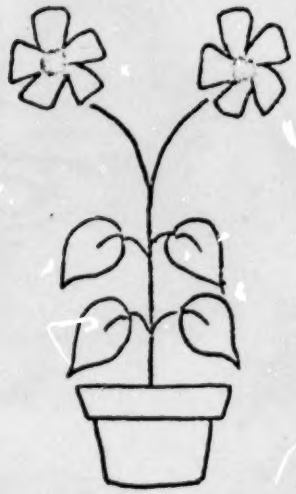
Number of Flowers: 2
Color of Flowers: red
Position of Flowers:
middle of plant

6



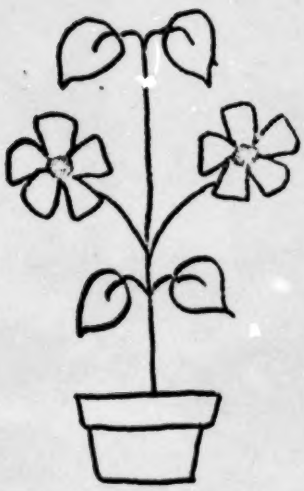
Number of Flowers: 2
Color of Flowers: yellow
Position of Flowers:
bottom of plant

7



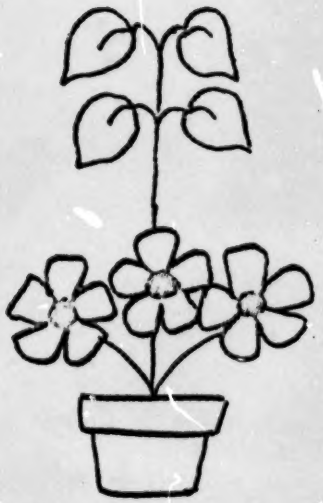
Number of Flowers: 2
Color of Flowers: yellow
Position of Flowers:
top of plant

8



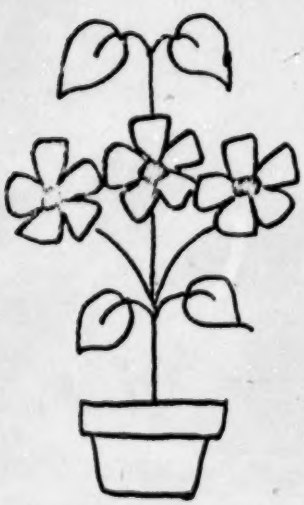
Number of Flowers: 2
Color of Flowers: blue
Position of Flowers:
middle of plant

9



Number of Flowers: 3
Color of Flowers: red
Position of Flowers:
bottom of plant

10

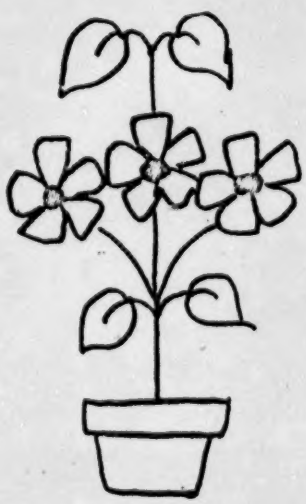


Number of Flowers: 3
Color of Flowers: yellow
Position of Flowers:
middle of plant

11

Number of Flowers: 3
Color of Flowers: blue
Position of Flowers:
top of plant

12



Number of Flowers: 3
Color of Flowers: red
Position of Flowers:
middle of plant

APPENDIX B

DESCRIPTION OF TEST ITEMS

Test Form	Item	Task	Objects
A	1	Identify classification variable (color of house)	houses
	2	Identify classification variable (number of flowers)	plants
	3	Classify according to color of flowers	plants
	4	Classify according to number of windows	houses
	5	Classify on any appropriate variable	insects
B	1	Identify classification variable (color of flowers)	plants
	2	Identify classification variable (number of spots)	insects
	3	Classify according to color of spots	insects
	4	Classify according to number of flowers	plants
	5	Classify many appropriate variables	houses
C	1	Identify classification variable (color of spots)	insects
	2	Identify classification variable (number of windows)	houses
	3	Classify according to color of houses	houses
	4	Classify according to number of spots	insects
	5	Classify on any appropriate variable	plants

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